Serum vitamin A levels in children with protein energy malnutrition

Author(s): Ikekpeazu Ebele J Neboh Emeka E Maduka Ignatius C. Ezedigbo Azubike N Odetunde Tola

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Ikekpeazu Ebele J[1], Neboh Emeka E[2], Maduka Ignatius C[3], Ezedigbo Azubike N[4], Odetunde Tola[5]

(1) Department of Medical Biochemistry, College of Medicine, University of Nigeria Enugu Campus, U.N.E.C, Enugu State, Nigeria
(2) Department of Chemical Pathology, College of Medicine, Enugu State University Teaching Hospital, E.S.U.T.H, Park lane, GRA Enugu State, Nigeria
(3) Department of Chemical Pathology, University of Nigeria Teaching Hospital {UNTH}, PMB. 01129, Enugu State, Nigeria
(4) Department of Medical Laboratory Sciences, Ambrose Ali University, Ekpoma, Edo State, Nigeria
(5) Department of Pediatrics, Enugu State University Teaching Hospital, E.S.U.T.H, Park lane, G.R.A, Enugu State, Nigeria

Abstract

Protein energy malnutrition (PEM) is central to paediatric mortality in most developing and underdeveloped countries. Deficiency of essential macro molecules such as proteins and weight loss has also been demonstrated in cases of PEM. This study is therefore designed to investigate the effect of malnutrition on serum vitamin A, which is essential for the visual cycle. The serum vitamin A level, serum albumin and body mass index of a total of 197 children was estimated. The test subjects included 99 malnourished children (with protein energy malnutrition) aged between 1-5 years and 98 apparently healthy age-matched children control. The mean ± SD of vitamin A, body mass index (BMI) and albumin of malnourished children (26.7 ± 19.7iu/L, 14.4 ± 3.7kg/m2 and 2.4 ± 0.5 g/dl) were significantly decreased (P<0.05) when compared with the control (128.2 ± 56.9iu/L, 22.7 ± 2.0 kg/m2 and 4.1 ± 0.5g/dl) respectively. The mean levels of vitamin A, BMI and serum albumin of the marasmic children and those suffering from kwashiorkor were both equally significantly decreased (P<0.05) when compared to the controls.

When comparison was done between malnourished children suffering from kwashiorkor and the marasmic children, significant decrease (P<0.05) was observed in serum albumin (P<0.05) of children suffering from kwashiorkor but not in serum vitamin A level and BMI. The study shows that vitamin A level is significantly lowered in malnourished children irrespective of the class of protein energy malnutrition and its supplementation is highly recommended for this category of children.

Key words: Protein energy malnutrition, serum vitamin-A, children
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Introduction

Malnutrition is a state of inadequate or improper nutrition, which may be caused by a combination of an insufficient intake of proteins, calories, vitamins and minerals as well as frequent infections [1]. Vitamins are organic substan-ces in food which are required in small amounts but cannot be synthesized by the body in adequate quantities [2]. Thirteen vitamins have been demonstrated to have clinical effects in humans and vitamin A is one of them. Vitamin A (retinol) found in milk, liver, milk, butter, egg yolk, vegetables etc is important in maintaining the integrity of epithelial surface, ensuring adequate structure and func-tion of the visual system, strengthening the immune system, ensuring adequate growth and development and helping in efficient utilization of iron for haemoglobin production [1].

The clinical effects of vitamin A deficiency have been classified as ocular and extra ocular. Ocular effects include loss of night vision, xerophthalmia and keratomalacia, whereas extra ocular effects include mild anemia and thickened rough skin [3].

A cross sectional study in Brazil reporting lower concentration of vitamin A in the cord-blood of smaller/shorter babies in comparison to heavier/longer babies, suggest a role for vitamin A in the promotion of growth [4]. It follows that a child with vitamin A deficiency may be more prone to nutrient losses through diarrhea and other infections, creating the setting for malnutrition [4].Vitamin A deficiency could result from habitually low intake as well as economic, social and environmental factors that limit access to the use of vitamin A containing foods [5; 6]. In developing countries, the prevalent form of childhood malnutrition is protein energy malnutrition (PEM), which refers to varying degrees of deficiency of protein and calories [7]. There are 3 clinical forms of PEM, which are kwashiorkor, marasmus and marasmic-kwashiorkor, each form depending on the balance between protein and non-protein sources of energy [8].

An objective diagnosis can be made using the welcome classification based on standard weight-for –age charts as well as presence or absence of edema. Body weight of less than 60% of the expected and without edema is marasmus, but with edema is marasmic kwashiorkor [9]. Kwashiorkor tends to be confined to parts of the world such as rural Africa, the Caribbean and the Pacific Is-lands, areas where staple foods are low in protein and high in carbohydrate [10]. Micronutrient deficiencies also occur and often the same child may have PEM as well as micronutrient deficiencies at the same time [5]. It has been estimated that globally, 150 million Children under the age of five are malnourished [5] while UNICEF states that 200,000 children go blind each year because they do not have enough vitamin A in their bodies. There is a global drive to address the issue of malnutrition especially in children since they are the future leaders. While some programs are aimed at reducing childhood infections by immunization others are aimed at micronutrient supple-mentation (eg.) iodized salt. It is thus very crucial to study the complex interplay of macro and micronutrient deficiencies that can lead to the disturbing problem of child-hood malnutrition, and the present study was therefore performed to determine the vitamin A level and evaluate the anthropometric measurements and albumin levels in malnourished children

Material and Methods

Subjects

A total of 197 children were recruited from Enugu and Ebonyi states of Nigeria for the study. The test subjects included 99 malnourished children (with protein energy malnutrition) less than 5 years of age, of which 60 were marasmic and 39 were suffering from kwashiorkor, whereas 98 apparently healthy age-matched children as control subjects. Appropriate ethical clearance was issued by the institution and informed verbal consent was obtained from the parents of all the subjects before the study commenced.

Sample Collection and Preparation

Standard method of blood collection [11] was adopted during the collection of blood samples. The collected blood samples (2 mls from each subject) were allowed to clot and then centrifuged at 3000rpm for 5 mins to obtain the sera. The separated clear sera were transferred into sterile tubes, capped and used immediately to assay for serum vitamin A and albumin.

BMI Calculation. (Anthropometric measurements)

Anthropometric measurements (weight and height) of the children were recorded to determine their nutritional status. Weights of the children were obtained to the near-est 100g using an electronic digital scale (Seca model 770; Seca Hamburg, Germany) and its accuracy was periodically verified using reference weights. Recumbent length or standing height was determined with a locally made instrument with a metal tape extending between a foot plate and a head bar, and the mean of two consecu-tive measurements to the nearest 0.1cm was recorded as the observed value. The body mass index (BMI) was cal-culated from the corresponding height and weight values.

Trained and experienced research assistants followed standard procedures in performing anthropometric meas-urements with an inter-worker reliability of nearly 95% [9].

Vitamin A Estimation

Serum vitamin A was estimated using trichloroacetic (TCA) method of [12] after extraction with petroleum ether.

Serum Albumin Estimation

Bromocresol green (BCG) method of albumin analysis was used for the study [13]. The kit reagents were produced by Quimica Clinica Aplicada, S.A. (QCA, S.A.)

Statistical Analysis

Data generated were expressed as mean ± standard devia-tion (± SD) and the differences between the means were determined separately using student's t-test. Serum vitamin- a levels in children with protein energy malnutrition. 11

Results

Table.1 shows the mean ± SD of serum vitamin A, Body mass index (BMI) and serum albumin of malnourished children with PEM and the control subjects. There was a statistically significant decrease ($P<0.05$) in serum vita-min A, BMI and albumin of the test subjects (26.7 ± 19.7 iu/L, 14.4 ± 3.7 kg/m2 and 2.4 ± 0.5 g/dl) when compared with the controls(128.2 ±56.9 iu/L, 22.7 ± 2.0 kg/m2 and 4.1 ± 0.5 g/dl respectively).

Table 1. Serum vitamin A, body mass index and serum albumin in the malnourished and control subjects.

	Malnourished Subjects	Control Subjects	
No of Subjects	**n=99 Mean ± SD**	**n=98 Mean ± SD**	**P-Value**
Vitamin A (mg/dl)	26.7 ± 19.7	128.2 ± 56.9	P<0.05 *
BMI (Kg/m2)	14.4 ± 3.7	22.7 ± 2.0	P<0.05 *
Albumin (g/dl)	2.4 ± 0.5	4.1 ± 0.5	P<0.05 *

*= Statistically Significant.

Table 2. Serum vitamin A, body mass index and serum albumin in the marasmic, kwashiorkor and control subjects.

	Marasmic Subjects	Kwashiorkor Subjects	Control Subjects	
No of Subjects	**n=60 Mean ± SD**	**n=39 Mean ± SD**	**n=98 Mean ± SD**	**P-Value**
Vitamin A (mg/dl)	26.6 ± 20.7	24.6 ± 30.2	128.2 ± 56.9	P<0.05 *
BMI (Kg/m2)	12.3 ± 2.7	12.3 ± 2.9	22.7 ± 2.0	P<0.05 *
Albumin (g/dl)	2.3 ± 0.3	0.4 ± 0.1	4.1 ± 0.5	P<0.05 *

* = Statistically Significant

Table 3. Comparison of the serum vitamin A, body mass index and serum albumin in the marasmic and kwashiorkor subjects.

	Marasmic Subjects	**Kwashiorkor Subjects**	
No of Subjects	**n=60 Mean ± SD**	**n=39 Mean ± SD**	**P-Value**
Vitamin A (mg/dl)	26.6 ± 20.7	24.6 ± 30.2	P>0.05
BMI (Kg/m2)	12.3 ± 2.7	12.3 ± 2.9	P>0.05
Albumin (g/dl)	2.3 ± 0.3	0.4 ± 0.1	P<0.05 *

* = Statistically Significant

The comparison of the mean values of serum vitamin A, BMI and serum albumin of the marasmic children (26.6 ± 20.7 iu/L, 12.3 ± 2.7 kg/m2 and 2.3 ± 0.3 g/dl) to the control subjects (128.2 ± 56.9 iu/L, 22.7 ± 2.0 kg/m2 and 4.1 ± 0.5 g/dl respectively) showed a statistically significant decrease (P<0.05) as shown in Table. 2.

Table. 2 also shows a significant decrease (P<0.05) in the vitamin A, BMI and albumin in the children suffering from kwashiorkor (24.6 ± 30.2 iu/L, 12.3 ± 2.9 kg/m2 and 0.4 ± 0.1g/dl) in comparison with the control (128.2 ± 56.9 iu/L, 22.7 ± 2.0 kg/m2 and 4.1 ± 0.5 g/dl respec-tively)

Finally, a comparison of the mean values of the children suffering from kwashiorkor and marasmic children showed a non significant difference (P>0.05) in the serum vitamin A and BMI while a significant difference (P<0.05) was observed in the serum albumin level. Table 3.

Discussion

The malnourished children (with PEM) included in this study involved both those suffering from kwashiorkor and marasmus. The study showed a significant fall (P<0.05), in the serum vitamin A level, body mass index (BMI) and serum albumin in children with protein energy malnutrition (PEM) when statistically compared with the control subjects. This observation is similar to that of earlier workers [14; 15; 16; 17], who attributed the fall in the above named parameters to be due to low intake and malabsorption of vitamin A-rich foods, inadequate hepatic stores of vitamin A and increased utilization during protein deficiency which impairs intestinal absorption, transport and metabolism of retinol and depresses conver-sion of carotene to vitamin A.

Children suffering from both kwashiorkor and marasmus showed statistically significant decreased levels (P<0.05), of the above mentioned parameters when compared to the control subjects. This finding is in agreement with that of [18], who reported that marasmic and kwashiorkor children show signs of vitamin A deficiency accompanied with low levels of serum albumin and decreased BMI.

However, when the comparison was done between the children suffering from kwashiorkor and those suffering from marasmus, decreased level was observed in serum albumin (P<0.05), but not in serum vitamin A and BMI. This correlates with the study of [19], which showed that in kwashiorkor, there is a reduction in total serum protein, especially the albumin fraction while in marasmus the reduction is usually much less marked, with the globulin fraction in the serum being normal or even raised.

Moreover, the reduction in Vitamin A level as seen in malnourished children (Children with PEM) could be the result of the effect of PEM which interferes with hepatic synthesis and release of retinol binding protein (RBP) required for vitamin a transport from the liver [20].This produces a defective retinol transport leading to a decrease in the serum retinol level, consequently, resulting in a defective visual cycle. The serum retinol transport system is also influenced by the body's nutritional vita-min A status.

On the other hand, there is also reduced serum protein levels especially albumin in PEM due to consumption of protein deficient diet. This is mostly associated with kwashiorkor, where the decrease in the serum albumin is accompanied with severe oedema. In marasmus the serum protein level maybe relatively normal or slightly raised due to the starvation adaptation in marasmus [19]. Ultimately, malnourished children have reduced body mass index resulting from wasting of fat and muscles. This is probably due to the body's use of alternative source of energy via the break down of storage macro molecules.

Conclusion

In PEM, the availability of vitamin A is decreased as a result of poor dietary intake which in turn decreases he-patic synthesis of retinol binding protein (RBP).The administration of vitamin A not only stimulates the release of apo-RBP but also the hepatic synthesis of RBP.

This study has clearly shown that vitamin A level is significantly lowered in malnourished children, which possibly predisposes the children to poor visual co-ordination and consequently, increased vitamin A supplementation, in addition to dietary protein and calories should be con-sidered for this category of children.

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Correspondence:
Ikekpeazu Ebele J
Department of Medical Biochemistry
College of Medicine
University of Nigeria Enugu Campus
UNEC, Enugu State, Nigeria
e-mail: iebelejoy(at)yahoo.com

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